Table 1. Movement Limits for Bridges (from Moulton, 1986)

Direction of Movement Magnitude most likely to cause intolerable damage	
Vertical Only	4 inches
Horizontal (Lateral) Only	2 inches
Both Horizontal and Vertical	
Vertical Component	2 inches
Horizontal Component	1 inch
Angular Distortion (Differential Vertical Displacement : Span Length)	0.004
Multispan structures have a higher frequency of severe structural damage due to foundation movements than single span bridges.	

Robinson et al. (2006) proposed mathematical models to estimate the loads required to cause expansion joints between adjacent bridge spans to close. These models required estimates of the abutment and substructure stiffnesses, as well as the rotation stiffness of the sub- to super-structure connection. These will be reviewed and discussed further in Chapter 6.

Drilled Shaft Bent Design

Drilled shaft bents are conceptually similar to driven pile bents, although the deep foundation elements are different. Drilled shaft bents tend to be selected in the following cases: where lateral loads are significant enough that the cross section and stiffness of a large diameter drilled shaft are required, where lateral resistance must be developed by socketing the shaft into weathered or crystalline rock, or where dense soil strata above the expected required tip elevation make installation of driven piles difficult or impossible without extraordinary secondary measures. Drilled shaft bents differ from pile bents in that the deep foundation elements must be sized for each bridge, instead of selecting from a range of pre-designed or manufactured driven pile types. Thus, drilled shaft design requires sizing of the reinforcement scheme for the shafts.

Geotechnical Design

As for driven pile design, the Geotechnical Unit typically estimates the size and length of the drilled shaft to be installed by performing axial and lateral analyses. The lateral and axial loads can be either assumed or preliminary loads are received from the Structures and Hydrology Units and used in the analyses.